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DRAFT GUIDE SYLLABUS FOR PROFESSIONAL STATISTICAL TRAINING

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INTRODUCTION

A. Aims and Objectives

The overall objective of the programme is to produce a graduate well equipped for,

(i) work in government or quasi government statistical agencies,

(ii) further training as potential teacher and/or researcher in higher institutions,

(iii) general applications of statistics eg. in research institutes, corporations etc.

While present day needs of a statistician are taken into consideration in the preparation of the syllabus, due cognizance is given to the long term requirements of a career statistician.

B. Basic Assumptions

The following are the assumptions made in drafting the Guide syllabus for Bachelor's Degree in Statistics.

(i) Students are assumed to enter having A-level matehmatics or equivalent.

(ii) The norm structure for the course to be borne in mind when considering the contents is to be 3:2:1 (subjects in first, second and third years respectively).

(iii) It is assumed that one of the other first year subjects is mathematics.

(iv) If mathematics is not taken as a full second-year subject, some supplementary instruction in mathematics will be necessary.

(v) The number of contact hours available for all subjects is assumed to be about 20 per week, for about 24 weeks per year: the total number available for statistics over the three years is thus about 880, though this has to include, presumably, any project work to be undertaken.

(vi) No options are planned, within statistics, for first or second year. The third year will need to have an option structure, as indicated later.

(vii) The number of contact hours shown for each course includes both teaching hours and time for practical work or tutorials.

C. Mathematics Requirement

Mathematics courses to be offered should be such as will aid students to understand appropriate statistics courses. Courses of purely abstract nature will not normally be ideal.

While some students may be inclined to do some mathematics in the third year, the general assumption is that first and second year mathematics should be adequate.

First year

Basic courses in:

(i) Algebra (including some linear algebra), introduction to groups, vector spaces, matrices.

(ii) Analysis: sets; real and complex numbers; notions of convergence and divergence, differential calculus, integral calculus.

(iii) Ordinary differential equation. Illustration of how differential equations arise; techniques for solving first and second order linear and non-linear equation; nth order linear equation etc.

Second year

Emphasis now on combination of topics that go to make what is often referred to as Mathematical Methods. Further ordinary differential equations; special functions; fourier series and integrals, partial differential equations (first and second order only). Elements of numerical analysis.

D. Practical Work, Projects, etc.

With respect to practical work etc, the following explanatory notes are relevant:

(i) The aim of bringing such work into the programme is to help reduce the gap between theory and methods, as they must inevitably be taught, and actual practice.

(ii) It is highly desirable that there should be at least one fairly substantial project as a requirement within the programme and that this should be to carry out a sample survey e.g. on a population of humans, businesses, holdings etc.; failing this it should be to carry out an experiment involving variable material. One important requirement is that difficulties should arise, so that the students may have developed a good understanding of the underlying theory and methods and so that they may more generally have developed some statistical maturity, this should come as late in the programme as possible, though for practical reasons the long vacation between second and third years may turn out to be best.

(iii) Another kind of practical work consists of 'drill' exercises, in which students have to carry out a specific type of analysis (e.g. regression) on a set of data. Such exercises are of course important, indeed essential, and should be set from the earliest stages on all material for which it is appropriate; it will often be convenient to attach such exercises to the course dealing with the relevant method. Although in this kind of exercise it will (usually) be clear which technique is

intended, this is not to say that it should be viewed as an exercise in arithmetic: except perhaps on the very first meeting with a topic the data should be real, or at least realistic, and it should be made clear why the analysis might be practically useful in that context. Incidentally it should be noted, both here and elsewhere, that it is the conceptual content rather than the computational load that is valuable: regression with two independent variables brings in ideas that are not relevant with one, but for most purposes the use of three variables merely entails heavier calculations.

(iv) Several advantages can be derived from drill exercises: they can help to show when techniques are applicable; how assumptions can be checked; and how results can be interpreted non-technically. Moreover, although arithmetic, as remarked previously, is not the point, they can provide practice in using calculators, computers, and so on.

(v) However the characteristic of drill exercises is that they are already in statistical language, or at least nearly so: regress y on x, or investigate how y varied with x. It is important also to encourage the students to translate real problems into statistical language, from an early stage, since otherwise the potential benefits of large projects will not be fully realised, and this requires a different kind of practical exercise. These should probably not be tied directly to a specific course, since if they are linked this helps the student to ignore the reality and get down to technique. Moreover there are other kinds of activity which may be considered here: for example the critical review of two or three papers on some application of statistics.

(vi) Drill exercises may just as well be done in class - in a so-called laboratory session for instance. The other kind of exercise, described in paragraph (v) above, is better done in the student's own time, to allow him time for thought, though this may not always be found possible for various practical reasons.

(vii) In this second kind of exercise students should be expected not only to translate a real problem into statistical language, but also to translate the answer back to the real problem. As a part of this, students should be required to write a report in a coherent form in acceptable English (or whatever the teaching language is), as they will no doubt be required to do in most forms of employment. Other non-technical aspects should also be insisted on, such as punctuality in the handing in of assignments, with penalties for lateness.

(viii) Consideration was given to the idea of listing a short course on communication in the programme, but this was rejected. However, students required to write reports, as suggested in paragraph (vii) will almost certainly need help in this initial guidance on structure and so on, correction of errors and suggestions for improvement attached to reports submitted, and so on. (For a very substantial project it may be appropriate to have a draft report submitted, to be revised in stages. For smaller projects it is probably more practicable to explain imperfections, but to expect the lessons learnt thereby to be applied to future reports). Another aspect of communication is the oral one. The possibilities here will depend on the numbers of students in the group and indeed on other circumstances, but if students can be given the opportunity to speak once or twice a year for, say, ten minutes on their projects this again will give them experience which will be valuable later.

(ix) No syllabus for practical or project work will be given. The person(s) in charge of such work should take into account the general guidelines given in this section in designing such work.

E. Books

For each course various books are listed; they are given in alphabetical author order. These are given so as to indicate in general terms the range of books available; there will usually be many authors on the same subject, some of which will be equally appropriate. Some books listed will serve as textbooks for the student, while others will only be useful as references for the teacher (student).

F. Course Structure

The course structure is as follows:

1st. Year Course	No. of hours allocated
S.101 Basic Introduction	15
S.102 Statistical Methods I	60
S.103 Probability	30
S.104 Economics for statisticians I	30
S.105 Accounting (for businesses)	15
S.106 Statistical Computing I	15
S.107 Practical work	30
Total	195

2nd. Year	
S.201 Statistical Methods II	30
S.202 Statistical Inference I	30
S.203 Probability, Stochastic Processes, Distribution Theory	30
S.204 Design of Experiments I	30
S.205 Operations Research I	15
S.206 Sample Surveys	30
S.207 Demography I	15
S.208 Economics for Statisticians II	30
S.209 Statistical Computing II	30
S.210 Project Work	30
Total	270

Third year

Course	No. of hours allocated
S.301 Statistical Inference II	30
S.302 Further Probability and Distribution Theory	30
S.303 Statistical Methods III	30
S.304 Design of Experiments II	30
S.305 Further Stochastic Processes	30
S.306 Multivariate Methods and Theory	30
S.307 Time Series	30
S.308 Demography II	30
S.309 Operations Research II	30
S.310 Industrial Quality Control	30
S.311 Statistical Computing III	30
S.312 Econometrics	30
S.313 Biometry	30
S.314 Sampling Techniques and Applications	30
S.315 Actuarial Statistics	30
S.350 Labour Statistics	30
S.351 Education Statistics	30
S.352 Health Statistics	30
S.353 Agricultural Statistics	30
S.354 Price and Quantity Statistics	30
S.355 Social Statistics	30
S.356 International Trade Statistics and Balance of Payments	30
S.357 National Accounts	30
S.358 Social Accounts	30
S.359 Food Accounts	30
S.360 Financial Statistics	30
S.361 Industrial Statistics	30
S.362 Transport and Communications Statistics	30
S.363 Distribution Statistics	30
S.364 Environment Statistics	30
S.365 Energy Statistics	30
S.366 Statistical Organization	30
S.367 Practical Work	30

There are three options in the 3rd year, with a core of subjects to be taken by all candidates. For ease of convenience, the three options are called Academic (A), Official (B) and other Applied (C). The B option is again subdivided into two streams: Economic statistics (B_1) and Demographic and Social statistics (B_2). The core comprises S.301, S.306, S.307, S.311 and S.367.

The A option is made up of: S.302, S.303, S.304, S.305, S.308, S.309, S.310, S.312, S.313, S.314 and S.315.

The B_1 option consists of: S.303, S.309, S.310, S.314, S.315, S.350, S.353, S.354, S.356, S.357, S.358, S.359, S.360, S.361, S.362, S.363, S.365 and S.366.

The B_2 option comprises: S.303, S.308, S.309, S.314, S.315, S.350, S.351, S.352, S.355, S.364 and S.366.

The C option is made up of: S.303, S.304, S.305, S.308, S.309, S.310, S.312, S.313, S.314, S.357, S.358 and S.359.

Candidates will be required to take the core together with 11 courses from the option of their choice.

II. FIRST YEAR COURSES

S.101 BASIC STATISTICS

This course has two aims. The first is the obvious one of introducing simple tools, such as graphs, tables and so on to the students. The other is perhaps more important to emphasise the broad nature and to describe the various aspects of the subject before the student is completely involved with technical details.

Course topics

1. General introduction: the nature of statistics [the combination of individual pieces of data into a whole, etc.]; illustrations of use - description, comparison, decision, prediction, etc.; types of data [ratio and interval measurement, count, proportion, categorical, etc.] observational and experimental studies.

2. Attitudes: Need for care; need for sufficient but not excessive accuracy; need to be specific and systematic [note and record source of data, units, exact definition, etc.]; need for integrity.

3. Descriptive methods: Stem and leaf charts; frequency distributions [one- and two-way]. Tables: construction, display and use.

4. Graphical displays: Simple graphs; scatter plots; pie charts, pictograms, bar charts; statistical display in map form.

5. Summary statistics: Measures of location; measures of dispersion; index numbers; measures of correlation.

6. Sources: Official - national, regional [provincial], local; international; unofficial.

7. Data Collection: Householder and canvasser methods; use of administrative records; censuses and sample surveys; simple random, stratified and systematic samples [description only]; precision, non-sampling errors; questionnaire design and content.

Total: 15 hours, at least 5 hours being in an exercise class. Item 2 should not receive much formal attention, except perhaps for integrity - it should come up and be stressed, naturally in applications: some of the items 3, 4, 6 and 7 are better done mostly by exercises; item 6 might instead be dealt with in Practical Work.

At various points it will be appropriate to draw attention to common misuses of statistics. Much of the subject matter of this course will recur frequently in the pro ramme; here only an introduction is intended.

Reading list

(i) Adamu, S.O. & Johnson T.L., Statistics for Beginners Evans Brothers (Nigeria Publishers) Ltd.

(ii) Afonja, Biyi, Introductory Statistics, Evans Brothers. (Nigeria Publishers) Ltd., 1982.

(iii) Reichman, W.J. Use and Abuse of Statistics. Penguin, London, 1964.

(iv) Tanur, J. (ed) Statistics. A Guide to the Unknown (2nd. ed.) Holden-Day, San Francisco, 1978.

(v) Tufte, E. The Visual Display of Quantitative Information. Graphics Press, Connecticut, 1983.

S.102 STATISTICAL METHODS I

1. Application of the normal distribution: Importance of the normal distribution in statistics; properties of the normal distribution and its application as a model for various kinds of data.

2. Repeated sampling: Use of random number table; distribution of sample statistics like the mean; cases of known and unknown population variances.

3. Inference about a population mean: Point/interval estimate; confidence limits and intervals; test of mean [large and small sample tests].

4. Comparison of means of two populations: Why compare populations [means]? Assumption of equality of variance. Reduction of two sample problem to one sample problem. Point/interval estimate of difference of the two means. Tests of equality of means.

5. Analysis of frequency data and proportions: Sampling from binominal population; estimation of proportion. Use of normal approximation; Test of association in 2x2 cross classified [contingency] tables.

6. Linear association [no statistical or probabilistic theory]: Linear regression: relationships between two variables: description, prediction (interpolation)
Linearity/non-linearity
[Straight] line of best fit - possible definitions. Residuals
Least squares (possibility of application to non-linear problems)
Residual plots
Measures of fit: residual sum of squares: R^2
Fitting with restrictions: line through the origin

7. From sample variance to population variance: Point/interval estimate of population variance and standard deviation; Test about population variance, use of chi-squared test.

8. Comparison of variabilities of two populations: Use of F - test to compare two variances.

9. Systematic discussion of basic concepts of inference: Distinction between statistical inference and ordinary [non-statistical] inference;
Inference as estimation and hypothesis testing;
Statistical error of wrong conclusion (Type I and Type II), significance level; p-values [i.e. achieved level of significance]
Test [null] hypothesis and alternative;
Hypothesis test through use of (a) confidence interval and (b) test statistics, and their relationship
One-tailed/two tailed tests.

10. Non-parametric inference

Meaning of non-parametric method; advantages [less assumptions, often simpler]; disadvantages [normally less efficient than appropriate parametric method, possible difficulty in treating question intended]
Basic concepts: ranks; order statistics
Simple tests: sign test, signed rank and rank sum tests; runs test.

11. Time series: Analysis of time series data; the forecasting of future values of a time series from current and past values.

Total: 60 hours, at least 20 hours being in an exercise or practical class; statistical packages should be used to a considerable extent. Examples should as far as possible be taken from real life situations.

Reading List

(i) Hoel, P.G. Elementary Statistics. Wiley and Sons, New York.

(ii) Snedecor, G.W. and Cochran, W.G. Statistical Methods (6th edition) Iowa State University Press, Ames, Iowa, U.S.A. 1967.

(iii) Sprent, P., Quick Statistics. Penguin, London.

(iv) Wetherill, G.B., Elementary Statistical Methods (3rd. ed.) Chapman and Hall, London 1982.

S.103 PROBABILITY

1. Uncertainty: Long term stability; frequency interpretation of probability. [Degree of belief - brief mention for contrast and comparison].

2. Mathematical Basis: Sample space; events. [Translation between mathematical set language and traditional probability language, e.g. exclusive = disjoint] Axioms of probability.

3. Dependence and Independence: Conditional probability, stochastic or statistical independence. [Cause and effect]. Bayes' theorem.

4. Random Variables: Definition [as functions on probability space]. Discrete case; distribution; probability mass functions. Continuous case; probability density function; distribution function. Distribution of a function of a random variable.

5. Expectation: Definition in probability space terms and in distribution terms and their equivalence. First properties: $E(aX) = aE(X)$; $X \geq 0 \rightarrow E(X) \geq 0$ $EX = 0$ and $X \geq 0 \rightarrow X = 0$ with probability 1. Moments. Expectation of a function.

6. Simple Discrete Models: Equiprobable events; the historical definition of probability. Uniform distribution. Bernoulli sequence [Binomial distribution; Geometric distribution; Negative binomial distribution]. Hypergeometric distribution.

7. Common Continuous Distributions: Uniform, negative exponential; normal.

8. Poisson Process: Number of events in fixed time interval; Poisson distribution. Poisson approximations to the binomial distribution. Time to first event.

9. Random Vectors: Independent random variables. (The Central Limit Theorem; the normal approximation to the binomial and to the Poisson distributions). Joint, marginal, and conditional distributions for discrete random variables. Expectations of functions (Covariance and correlation). Multinomial distribution.

Note: A total of 30 hours is to be devoted to this subject of which about a third will be for exercises.

Reading list

(i) Feller, W. Introduction to Probability Theory and its Applications, Vol. I. Wiley and Sons, New York.

(ii) Meyer, P.L., Introductory Probability and Statistical Applications (second edition), Addison-Wesley, Reading Massachusetts.

(iii) Mosteller, F. Rourke, R.E.K. and Thomas, G.B. Probability with Statistical Applications, Addison-Wesley, London.

(iv) Ros, S.M. A first course in probability. Collier Macmillan, New York.

(v) Spiegel, Murray R.,Theory and Problems of Probability and Statistics (Schaums outline series) McGraw Hill.

S.104 ECONOMICS FOR STATISTICIANS I

1. Macro-economic Theory: Introduction to economic principles and methodologies including national income, money and banking, fiscal policy, economic fluctuations; relationships between savings, consumption and investment; concepts and definitions of national income; methods for measurement of national products; basic analytical concepts of the simple theory of aggregative income determination; resource allocations; conditions of static and dynamic equilibrium; studies of economic cycle.

2. Micro-economic Analysis: Analysis of the operation of an economy in the determination of product prices, wage rates, level of output by the firm, the distribution of income, economic agents and economic institutions, market processes, demand and supply analysis; theory of the firm, labour, rent interest and profits; cost and production function; profit maximization theory, income distribution, Gini's coefficient, Lorenz curves.

3. Public Finance: Government expenditure, taxation, budgeting, and public debt management in relation to resource allocation, income distribution and economic stability; analysis of different types of taxes and public expenditure; fiscal policy and fiscal balance; methods of financing budget deficits.

4. Money and Banking: Nature and functioning of the modern banking system, the creation of money and bank deposits; savings and other financial institutions; the determinant of money supply, relationship between prices and money; the simple quantity theory of money, inflation and deflation; the effect of inflation; the operation of monetary policy.

5. Index numbers: Interpretation and use. Laspeyres, Paasche and Fisher indices.

Note: A total of 30 hours will be devoted to this course, of which one third (i.e. 10 hours) should be spent on exercises.

Reading list

(i) Lipsey, R.G. Introduction to Positive Economics, 6th ed. 1983, Weidenfeld & Nicolson.

(ii) Samuelson, P.A. Economics, An introductory analysis, McGrawhill.

(iii) Wonnacutt, R.J. and Wonnacutt, T.H. Econometrics, John Wiley & Sons, Inc.

S.105 ACCOUNTING

In such a short course it is clearly possible to cover only a rather limited amount of material. The course outlined below concentrates on analysis, and aims at leading to an understanding of financial statements and of budgets, rather than on construction of statements or on accounting systems. The material should be covered by means of a case study - preferably local. The purpose is twofold: to give statisticians a basic knowledge which allows them (a) to understand the language and ideas used in the financial planning and control of their own employing institution, and (b) to act as a member of a team discussing the characteristics and dynamics of private and public sector enterprises.

Course topics

Purposes of accounting.

Financial and management accounting planning and policy: the construction and analysis of budgeted financial and management accounting systems for these purposes.

General introduction to the design and use of management accounting systems for control purposes.

Reading list

(i) Bull, R.J. Accounting in Business (3rd ed.) Butterworths 1976.

(ii) Edey, Harold C. Business Budgets & Accounts (3rd ed.) Hutchinson, 1966.

(iii) Palmer, R.E. & Taylor, A.H. Financial Planning & Control. Pan Books. 1969.

S.106 STATISTICAL COMPUTING I

The use of the computer for data analysis and data processing increases is importanceevery year, and this part of the programme is very important. It is even more important for the instructor to bear constantly in mind the fact that the aim is not to impart knowledge for its own sake but to make it possible to use the computer.

Course topics

1. General computing: How computers work; introduction to types of problems computers can solve, e.g. calculation, text editing, data management; general structure of installation e.g. CPU, peripherals. Mainframe versus stand - alone micro computers, networking, etc. [brief general introduction].

2. Introduction to BASIC or other simple high level language: Writing of very simple programmes [e.g. read numbers, make a simple arithmetic operation and print the result]; running this programme by the students; flow chart - structured programming and documentation including use of COMMENT statements; further simple programmes in connection with an introductory statistical course [practical work to be shared between the computing and statistical courses]. difference between machine codes, high level language, packages; first use of one package [such as MINITAB*] [practical work shared with other statistics courses]; introduction to files.

3. Survey applications: Integration of data processing in the survey cycle; experience of complete planning/processing; sequence of survey data - or census files - processing operations; overall system design for surveys [table planning, questionnaire planning, coding, data entry]; administrative control of documents. Possibility of error detection and quality control by computer. Processing, tabulation, report generation, processing of a survey using a simple micro-computer package.

Note: A total of 15 hours is to be devoted to this course. Practical work will be done mainly as part of other statistics courses.

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* Minitab is just an example of an easy to use package which has a good range of appropriate facilities including the possibility of doing further analyses on earlier results.

Reading list

(i) Cooke, D., Craven, A.H. & Clarke, G.M. " Basic Statistical Computing", London, Edward Arnold, 1982.

(ii) Ryan, Thomas A. Jnr., Joiner, Brian L. & Ryan, Barbar F. "Minitab Student Handbook", Massachusetts, Duxbury Press, 1976.

(iii) Tennant - Smith, J. "Basic Statistics", London, Butterworths, 1985.

S.107 PRACTICAL WORK

See Introduction, section (D).

III. SECOND YEAR COURSES

S.201 STATISTICAL METHODS II

This course, placed in the middle year of the three, is also central in another sense: it treats the most important cases of the linear model, which has long been at the heart of statistical analyses of data and will no doubt continue to be so, systematically. The course is to be a methods course, however, rather than one intended to develop the theory for its own sake, and it is essential that the relationship with applications to real problems - not just to real data, though that is certainly important - be kept continually in front of the student. Thus each new technique should be motivated by real problems and illustrated by realistic data. Although section 1 appears small, and is in any case difficult to spend much time discussing in the abstract, its spirit should pervade the course, so that students do not perceive rather routine estimation and testing of a prescribed or assumed model as the only important aspects of statistical method. Section 8 which relates to a particular facet of the other aspects (to the checking that the model is adequate), will assist in this and should not be left to the end; from the very beginning students should be expected to plot or otherwise investigate residuals so that it becomes second nature to consider whether the usual regression model, with assumptions of normality and so on, is really applicable to the data in hand.

Course topics

1. Review of Statistical Approach: Data exploration versus testing and analysis of hypothesised model. The statistical cycle - Identification [of model] → Fit [=estimate] model → check for goodness of fit → Identification of revised model if necessary.

2. Further Problems arising from two Normal Samples: Comparison of variances; Behrens - Fisher problem. [mention only]

3. Analysis of Variance (ANOVA): Comparison of two population means by ANOVA - intuitive basis; equivalence to t-test. Model and assumptions. Extension to three or more groups.

4. Linear Regression: Least-squares and its connection with maximum-likelihood for the normal model. Estimation of σ^2. Review of one-way ANOVA; simple linear regression from this point of view. [Estimation of slope, and of σ^2; variance of estimate of slope; test for given slope; confidence interval for points on line; tolerance interval for new observations]. Connection with correlation. Prediction of explanatory variable from the dependent variable.

5. Multiple linear regression: (two explanatory variables to receive emphasis): Estimates and confidence intervals for coefficients; estimate of σ^2. Repeated observations for same x-estimate of true error and test of lack of fit. Multiple correlation coefficient - as correlation between dependent variable and fitted value, and as maximum correlation with linear combinations of predictors. Partial correlation - relationship to total correlation [interpretation and examples only - no general formulae]. ANOVA. The use of dummy variables.

6. Analysis of Categorical Data: Tests of goodness-of-fit and of homogeneity; X^2 ; tests of independence in general rxc contingency tables. McNemar's test for paired data.

7. Further ANOVA: General linear model. Contrasts - estimates; orthogonality; contribution to sum of squares. Sub-hypotheses - subdivision of sum of squares. Distribution of sum of squares; F-tests. [No proofs]. Balanced two-way tables, without interaction, with and without replication. Balanced two-way tables with interaction.

8. Regression Diagnostics: Assumptions underlying regression. Least-squares residuals. (Residuals standardised to have constant variance). Residual plots - [normal] probability plots; plots against fitted values; plots against explanatory [independent] variables; field and index plots [i.e. against actual position in real world - in space or time - in which observation arises]; scatter plots of ei against e_{i+1}

Note: A total of 30 hours will be required of which about 10 hours should be devoted to exercises which particularly emphasise real or realistic problems.

Reading list

(i) Davies, O.L. et al. Statistical Methods in Research and Production
Oliver and Boyd, Edinburgh.

(ii) Ostle, B. Statistics in Research. Iowa State University Press.

(iii) Snedecor, G.W. and Cochran, W.G. Statistical Methods (6th ed.)
Iowa State University Press.

(iv) Weisberg, S. Applied Linear Regression. Wiley, New York, 1982.

(v) Wetherill, G.B. Intermediate Statistical Methods
Chapman and Hall, London, 1981.

S.202 STATISTICAL INFERENCE I

1. Statistical inference as point/interval estimation and hypothesis testing: Properties of good estimate: unbiasedness - choice among unbiased estimates; (consistency - examples of consistent estimators) closeness - minimum mean square error and minimum variance criteria; Cramer-Rao lower-bound.

2. Sufficiency: Notions of sufficient statistics, identification through factorization and Fisher-Neyman's characterization theorem; Two parameters and joint sufficiency.

3. Methods of estimation: Maximum likelihood method - likelihood function, properties of maximum likelihood estimates; numerical [including iterative] determination of MLE in simple cases; least square estimates; method of moments; equivalence/nonequivalence of estimates using different methods.

4. Interval estimates: Confidence intervals [one parameter].

5. Hypothesis tests: Simple null hypothesis versus simple alternative hypothesis; likelihood ratio, critical region; size and power of test; Neyman - Pearson lemma; simple null versus composite alternative hypothesis; uniformly most powerful test, equitailed test, likelihood ratio test [no asymptotic theory].

Note: A total of 30 hours will be required for this course of which about 10 hours will be devoted to exercises.

Reading list

(i) Hogg, R.V. and Craig, A.T., Introduction to Mathematical Statistics (4th ed.) John Wiley and Sons, New York.

(ii) Mood, A.M., Graybill, F.A. and Boes, I.C., Introduction to the Theory of Statistics (3rd ed.) McGraw Hill.

S.203 PROBABILITY, STOCHASTIC PROCESSES, DISTRIBUTION THEORY

This course has three main aims:

(a) to complete the process begun in S.103 of providing a good grounding in the basic theory and techniques of probability. Aside from the sections explicitly devoted to this (1,2,3,5,6), probability theory supports distribution theory and stochastic processes, both of which provide examples of, and practice in the use of, probabilistic arguments for students; note that partly because of lack of time within the present framework, and partly because of the greater sophistication required of students, limit theorems and most material on generating functions are postponed until the third year;

(b) to complete the basic distribution theory required for statistics at this level; note that section 6 has relevance to simulation, which is treated in S.209.

(c) to introduce some of the important relatively simple stochastic process models, both for their own sake and as illustrations of the applications of probability.

As far as (c) is concerned the emphasis should be on the modelling aspects, rather than on the theory itself, with examples of practical applications discussed: for example, relatively simple Markov chain models have been used in social statistical contexts such as manpower planning and migration analysis as well as in more traditional physical areas, and queuing models have been applied to job scheduling in computers.

Course topics

1. Probability: Revision of basic material; extensions, such as use of indicator variables, formula for $P[A_1 \cup A_2 \cup \ldots \cup A_k]$; inequality $P(A_1 \cup A_2 \cup \ldots \cup A_n) \leq P(A_1) + P(A_2) + \ldots + P(A_n)$.

2. Joint, Marginal and Conditional Distributions [Emphasis on bivariate case; possible reference to general multivariate situation]: Extension to [absolutely] continuous case. First introduction to functions of two variables [no Jacobians]. Treatment of $E[Y|X]$ as random variable; relationship $E[E[Y|X]] = E[Y]$.

3. Bivariate Normal Distribution: Bivariate case: joint, marginal, and conditional distributions; linear combinations of [dependent] normal variables. Regression functions $E[Y|X]$ and $E[X|Y]$.

4. Standard Distributions: Gamma; Beta. Derived distributions: t, χ^2, F. Brief reference to their inter-relationships. Brief review of uses. Reference to tables.

5. Inequalities: Markov, Chebyshev; Usefulness in estimation of probabilities.

6. Functions of Random Variables (and Random Vectors): Probability integral transform [continuous case only]; inverse of this, with application to obtaining random deviates from specified distribution. Expectation and variance of linear combinations of random variables. Order- statistics - definition; distribution of $X_{(1)}$, $X_{(n)}$, median of simple random sample [continuous case only].

7. Generating Functions: Definition and introduction to use of probability generating functions and moment generating functions.

8. Markov Chains [Stationary transition probabilities only]. The Markov property and its importance. Discrete-time Markov chains: Transition matrix; Chapman-Kolmogorov equations. Geometric holding times. Stationary [equilibrium] distributions [no limits at this stage].

9. Continuous-time Processes: Review of Poisson process. Birth and death processes. [Forward] differential equations. Stationary distributions; detailed balance equations.

10. Queuing Models: General introduction to queuing systems. Deterministic approximations; applications to heavy traffic. M/M/1 queues in continuous time GI/M/1 - embedded Markov chain analysis; stationary distribution. Simulation of queuing systems (see also S.209)

Reading list

(i) Hogg, R.V. & Craig, A.T. Introduction to Mathematical Statistics (3rd ed.) John Wiley & Sons. New York.

(ii) Mood, A.M., Graybill, F.A. and Boes, D.C. Introduction to the Theory of Statistics (3rd ed.) McGraw Hill.

S.204 DESIGN OF EXPERIMENTS I

1. Principles of experimentation: Nature of scientific investigation; Experimental objective - knowledge about population [universe]; statistical objectives; optimal procedures for collecting and analysing data; role of randomization, replication and local control of error; definition of treatment, experimental units; design by examples/illustrations.

2. Some common designs: Completely randomized design [zero-way elimination of variation]; randomized complete block designs [one-way elimination of variation]; rationale for blocking, simple case of two treatments and paired comparison, analysis; latin squares [two-way elimination of variation]; rationale, randomization, analysis; relative merits of the designs.

3. Introduction to factorial experiments: Simple examples of experiments involving more than one factor; one factor at a time versus factorial approach.

4. Factors at two levels [2^n design]: the 2^2 and 2^3 designs; definition, calculation and interpretation of main effects and interactions;

Note: A total of 30 lecture hours will be required. About 10 hours of this should be devoted to practical exercises.

Reading list

(i) Hicks, C.R., Fundamental Concepts in the Design of Experiments. (2nd ed.) Ho H. Rinehart and Winston.

(ii) Mead, R. and Curnow R.N. Statistical Methods in Agriculture and Experimental Biology. Chapman & Hall.

(iii) Montgomery, D.C., Design and Analysis of Experiments. John Wiley and Sons.

S.205 OPERATIONS RESEARCH I

1. Optimisation: Brief survey of optimisation problems.

2. Linear programming: Graphical solution of two-variable problem. Simplex method. Sensitivity analysis. Transportation and assignment problems.

3. Networks: Networks; nodes, links; directed and undirected graphs. Types of problems- critical path, maximal flow, shortest path, minimum network cost. Critical path analysis (Shortest path algorithm; variability; PERT).

Note: A total of 15 hours will be devoted to this course, of which one-third will be for practical exercises/tutorials.

Reading list

(i) Buffa, E.S. and Dyer, J.S. "Management Science/Operations Research" John Wiley 1981 (2nd ed.).

(ii) Smith, D.K. "Network Optimisation Practice: a computational guide". Ellis Horwood 1982.

(iii) Vajda, S. "Linear Programming" Science Paperbacks, Chapman & Hall 1981.

S.206 SAMPLE SURVEYS

1. Uses, scope and advantages of sample surveys: Census vs survey. Additional information in censuses, advance tabulations in censuses, market research, quality control. Scope - national or subnational, special groups, unisubject or multisubject. Advantages - lower costs, quicker results, better quality data.

2. Types of surveys: By subject coverage (e.g. household consumption, expenditure, income, assets, debts, labour force, employment, unemployment and under-employment; demographic characteristics, household and family structure, position of women and children; fertility, mortality and migration; conditions of housing, water supply, health, nutrition, education, literacy, culture, and access to and use of related facilities/services; productive activities and outputs of households including household enterprises - agriculture, industry, trade - and access to and use of related facilities etc.); by unit of inquiry (household, establishment, holding, outlets, individuals, etc.); by mode (single-round retrospective, multi-round, "continuous" observation, longitudinal, etc.)

3. Survey organization: Principal steps in a sample survey, survey programming, survey budget. Calendar of principal activities. Manpower requirements; budget; Questionnaire design; Data processing arrangements, Dummy tables. Pre-tests. Field organization. Training of field workers. Preparation of enumeration manuals and training materials. Analysis of results. Report writing. Publication and dissemination of results.

4. Sample design: Frame construction (list and area frames). Master samples. Sampling units. Purposive, probability and quota sampling (basic ideas only). Simple random sampling with or without replacement. Sample size. Stratified sampling. Systematic sampling. Multi-stage sampling. Area sampling and PPS selections (non-mathematical treatment). Estimation of means, total and proportions. Variance calculation. (No proofs required). Sampling error.

5. Errors Sources, types [coverage and non-coverage], methods of minimising contribution to total survey error. How to deal with non-response [simple techniques only].

6. Management of surveys: Monitoring and review. Quality control.

Note: A total of 30 hours will be required for this course, excluding exercises which will be done as homework.

Reading list

(i) Barnett, V., Elements of Sampling Theory, EUP London, 1975.

(ii) Cochran, W.G., Sampling Techniques (3rd ed.), John Wiley & Sons, 1979, New York.

(iii) Jensen, J.W., Statistical Survey Techniques, John Wiley and Sons Inc., New York.

(iv) Kish, Leslie, Survey Sampling, John Wiley and Sons, Inc., New York.

(v) Moser, C., and Kalton, G., Survey Methods in Social Investigation.

(vi) Raj, Des., The Design of Sample Surveys, McGraw Hill, 1972.

(vii) Sampford, M.R., Sampling Theory.

(viii) Stuart A., The Ideas of Sampling, Griffin, High Wycombe, U.K., 1983.

(ix) Warwick, D.P., and Lininger, C.A. The Sample Survey: Theory and Practice.

(x) Yates, F., Sampling Methods for Censuses and Surveys, Griffin, London.

S.207 DEMOGRAPHY I

1. Introduction: Scope of demographic and socio-economic data. Uses and importance of demographic data. Demographic situation in Africa . Population pyramids. Demographic concepts and measures - what are we trying to estimate and why?

2. Alternative Strategies for the Collection of Demographic Data: Sources of data - census, registration, surveys, administrative and other records. Types of data collected - demographic, socio-economic, geographic, etc. Definition of population - de facto, de jure, modified and their advantages and disadvantages. Methods of enumeration - interviewer (canvasser), householder, mail; individual, group assembly; special techniques for enumerating nomads, semi-nomads, remote area dwellers. Sample versus complete coverage. Data availability - national publications, international agencies (UN and other).

3. Demographic Measures: Cohort and period concepts. Rates and ratios. Standardisation. Deterministic or stochastic interpretation?

4. Determinants: Fertility, mortality and migration - African situation.

Note: A total of 15 hours will be devoted to this course, of which one-third will be for practical exercises/tutorials.

Reading list

(i) Barclay, George, W. "Techniques of Population Analysis". New York, Wiley. London, Chapman & Hall.

(ii) Kpedekpo, G.M.K. "Essentials of Demographic Analysis of Africa, Heinemann.

(iii) Polland, A.H. Yusuf, F., & Pollard, G.N. "Demographic Techniques" New York, Pergamon Press.

(iv) Pressat, Roland. "A Workbook in Demography" London, Methnen.

S.208 ECONOMICS FOR STATISTICIANS II

1. International Economics: Theories of international trade, income effect; balance of payments adjustment; theory of exchange rate adjustments; special drawing rights (SDR), foreign trade policies.

2. Economic Development and Growth: Definitions and concepts of developing economies; various economic development theories under different economic systems; the structure of African economies; population and development; education and development; agriculture versus industry; the role and potential of the informal sector; economic growth and employment; the role of aid in economic development.

3. Introduction to Quantitative Economics: Use and scope of economic policy models, meaning and importance of forecasting in economic policy models; different types of development planning models; brief review of linear models (the case of simultaneous estimation techniques); economic and business statistics; input-output analysis - potential and limitation in the African context; introduction to resource allocation under uncertainty; theory of games and economic choices.

4. Socio-economic Indicators: Statistical requirements for development of indicators: basic needs, employment, household expenditure, income and assets, economic activity, social cohesion, cultural development etc.

Note: A total of 15 hours will be devoted to this course, of which a third will be for practical exercises.

Reading list

(i) Allen, R.G.D. An Introduction to National Accounts Statistics, Macmillan, 1980.

(ii) Allen, R.G.D. Index Numbers in Theory and Practice, Macmillan, 1975.

(iii) Beckerman, W. An Introduction to National Income Analysis, Weidenfeld and Nicholson, 1968.

(iv) Dernburg and McDougall. Macro-economics, McGraw-Hill.

(v) Elkan, W. Introduction to Development Economics, Penguin, 1973.

(vi) Furness, E. Money and Credit in Developing Africa, Heinemann Educational Books.

(vii) Harvey, C. Macro-economics for Africa, Heinemann Educational Books.

(viii) Kendrick, J.W. Economic Accounts and their Uses, McGraw-Hill, 1972.

(ix) Killick, A.C. Policy Economics, Heinemann Educational Books.

(x) Laidler, D. Micro-economic Theory.

(xi) Livingstone, I. ed. Economic Policy for Development, Penguin, 1971.

(xii) Livingstone, I. and ORD, H.W. Economics for East Africa, Heinemann Education Books, 1981.

(xiii) Robinson, J.N. Planning and Forecasting Techniques, Weidenfeld and Nicholson, 1972.

(xiv) Robson, P. and Lury, D. (ed), The Economics of Africa, Allen and Unwin, 1969.

(xv) Todaro, M.P. Economics for the Third World, Longman.

(xvi) Todaro, M.P. Economic Development in the Third World, Longman, 1981.

(xvii) Todaro, M.P. The Struggle for Economic Development, Longman, 1983.

(xviii) Usher, D. The Measurement of Economic Growth, Basil Blackwell, 1980.

(xix) Whethan, E.H. and Currie, J.I. Readings in Applied Economics of Africa, Vol. 1. Micro-economics, Vol. 2. Macro-economics, Cambridge University Press, 1969.

S.209 STATISTICAL COMPUTING II

A. GENERAL COMPUTING

1. General Aspects: Operating systems [brief]; compiled and interpreted languages. Introduction of new language [if possible Fortran]. Writing of simple programs. Introduction of new package, e.g. SPSS.

2. Further Considerations: Program features [accuracy - depends on algorithm and machine word length; speed - algorith and machine]. Languages, packages. Operating Systems. (Portability/compatibility; ease of use; menus, prompts, 'help' systems; batch processing, interactive use - advantages for exploratory work of interactive capability).

B. SOME CONCRETE APPLICATIONS

3. Simulation: Need for and approach to simulation of systems; simulation of simple deterministic systems; stochastic systems. (Random and pseudo-random numbers - advantages of, and need for, pseudo-random numbers. Generation of uniform variables: congruential methods· tests of randomness. Generation of variates from other distributions by inverse probability integral transforms. Simulation of simple stochastic systems. Simulation of inventory and stock-control systems). [Even if simulation languages/packages are available, some program writing in Fortran should be demanded, for practice].

4. Surveys: Questionnaire design: Computing/data processing aspects. Data editing and correction (on line validation; deferred control and data editing techniques - cold-deck and hot-deck methods), editing and imputation principles; writing of edit specifications; an edit package (e.g. CONCOR) will be introduced. Tabulation: table design; writing of table specifications; a tabulation package (e.g. CENTS-4) will be introduced.

Note: A total of 30 hours will be devoted to this course. Practical exercises will be done in relation to the other statistical courses.

Reading list

Morgan, Byron J.T. Elements of Simulation, London, Chapman & Hall, 1982.

S.210 PROJECT WORK

See Introduction, section (D). The best time for this work is the long vacation between the second and third years.

IV. THIRD YEAR COURSES

S.301 STATISTICAL INFERENCE II

1. Further Inference: Maximum likelihood estimation - review, extension to vector case; numerical calculations. Generalised likelihood ratio test; asymptotic properties. Basic notions of multiple comparisons - change in effective significance level [emphasis on the practical aspects, rather than on theory or on details of various procedures].

2. Bayesian inference: Problems associated with classical [sampling theory] approach; Bayes' approach - prior and posterior distributions; specification of prior distributions; elementary Bayesian decision theory; examples of situations in which Bayesian and classical approaches give equivalent or nearly equivalent results.

3. Semi-empirical approaches: Monte-Carlo methods. Jack knife. Bootstrapping.

4. Sequential methods: Sequential Probability Ratio Test (SPRT); Stein fixed-width confidence intervals.

Note: Detailed proofs only where they throw light on concepts, otherwise outlines of proofs will be enough. A total of 30 hours of lectures will be devoted to this course. Exercises will be done as home work.

Reading list

(i) Barnett, V., Comparative Statistical Inference.

(ii) Hogg, R.V., and Craig, A.T., Introduction to Mathematical Statistics (4th ed.) John Wiley and Sons. New York.

(iii) Mood, A.M., Graybill, F.A. and Boes, D.C., Introduction to the Theory of Statistics (3rd ed.) McGraw Hill .

S.302 FURTHER PROBABILITY AND DISTRIBUTION THEORY

1. Generating Functions: Probability generating functions; application to determination of moments, to sums of independent random variables and to solutions of equations for birth and death processes and queuing models; uniqueness theorem. Moment generating functions and characteristic functions; application to determination of moments and to sums of independent random variables; uniqueness theorem [outline proof at most]; generating functions for random vectors.

2. Multivariate Normal Distribution: Definition and properties [pdf in non-singular case; characteristic function; random vector is multivariate normal if and only if every linear form is univariate normal]. Marginal and conditional distributions of subsets. Distributions of [vector] linear transforms.

3. Quadratic Forms in Normal Variables: Motivation by applications to ANOVA; introduction to distribution theory - χ^2 [central and non-central], one quadratic form and independence of two quadratic forms; independence of linear form and quadratic form - application to mean and sample variance.

4. Functions of Random Variables and of Random Vectors: Distribution of sum of two random variables; independent case (convolution). Comparison of two approaches - (i) find distribution of f(X,Y) conditional or X, then 'integrate out dependence on X';(ii) transform X,Y to U = f(X,Y) and convenient V. Joint distribution of pairs of order statistics [continuous case only].

5. Convergence and Limit Theorems Convergence in distribution; application of characteristic functions [no proofs]. Central limit theorem for independent, identically distributed, random variables. Convergence in probability. Weak Law of Large Numbers. Almost sure convergence and the Strong Law of Large Numbers [brief introduction only].

S.303 STATISTICAL METHODS III

This course belongs to the core, intended to be taken by all students no matter what their final destination, and this must be borne in mind in the detailed planning and in the teaching. It contains some supplementary material on methods introduced earlier and introduces in general terms some new topics such as multivariate analysis.

Course topics

1. General Linear Model Theory: Matrix approach. Gauss-Markov theorem. Normal model-maximum likelihood. (Reduction to canonical form. Independence of coefficients and residuals). Non-full-rank case [brief discussion only].

2. Transformations: Possible aims - stabilisation of variance, reduction to preferred distributional properties [symmetry, normality], linearisation or other simplification of form of relationship. Possible conflicts between these, and with main objective of investigation and with simplicity of interpretation. Informal and formal approaches to selection of transformation. Relationships: Box-Cox family and transformation of y; transformation of x.

3. Further Aspects of Regression: Non-linear relationships: use of transformations, polynomial regression. Collinearity. Outliers. Review of material on residuals. Adjusted residuals (leave-one-out residuals, recursive residuals; measures of influence).

4. Random Effects Models: Estimation of variance components in simple one way and two way models [hierarchical (nested) and crossed].

5. Multivariate Statistics: Practical examples. Examination of data matrix, reduction of the data matrix; definition and calculation of sample summary statistics - means, variances, covariances, correlation; examination and interpretation of sample correlation matrix.

Reading list

(i) Dobson, A.J. An introduction to statistical modelling. Chapman & Hall. London.

(ii) McCullagh, P and Melder, J.A. Generalised linear models. Chapman & Hall. London .

S.304 DESIGN OF EXPERIMENTS II

The emphasis of this course should be firmly on those aspects of design which are relevant to the practice of statistics: that is on the choice of design and on the way in which the analysis is related to the design. Mathematical theories of construction of design are to be avoided, as are other general theoretical results such as, for example, those about confounding systems.

Course topics

1. Review of experimental and statistical objectives

2. General 2^n design (n factors at 2 levels): confounding; practical illustration of the need for reduction in block size; confounding of one or more effects, defining contrasts and block formation: partial confounding, fractional replication - using one-half, one-quarter fraction, general case, block compositions - meaning and use of such concepts as aliases, generators, defining contrasts, principal fraction.

3. Factors at 3 levels: 3^2 and 3^3 experiments with and without confounding: estimation of effects, meaning of effects in terms of response curve for case of quantitative factor. [Brief treatment only].

4. Subdivision of plots: split plot design (as example of factorial experiment)

5. Incomplete block designs: general nature and need for incomplete blocks, types of designs, balanced designs and their importance, balanced incomplete block design (intra and interblock analysis); partially balanced incomplete blocks - two-associate class only; others such as Youden squares, lattice designs; relative merits and appropriateness of the designs vis-a-vis objectives of the investigation; practical illustration of the various designs.

6. Introduction to response surface methodology: first order designs; second order designs.

7. Planning of experiments: considerations of choice of design; brief introduction to some such issues as economic consideration, precision etc.; treatment design (selection of treatments); experimented design (arrangement of treatments). Determination of optimum plot/block size and shape.

8. The role of the statistician in the various stages of an investigation: viz. planning, design, data collection and analysis; use of at least one real life investigation in any appropriate area such as agriculture, medicine (clinical trials), psychology, industry etc.

Note: 30 hours will be devoted to this course, a third of which will be for tutorials/practicals.

Reading list

(i) Box, G.E.P., Hunter, J.S. and Hunter, W.G., Statistics for Experimenters.

(ii) Cochran, W.G. and Cox, G., Experimental Designs.

(iii) Cox, D.R., Planning of Experiments, Wiley.

(iv) Davies, O.L. (2nd ed.) Design and Analysis of Industrial Experiments.

(v) Finey, D.J., Experimental Design.

(vi) John, J.A. and Quenouille, Experiments: Design and Analysis.

(vii) Montgomery, D.C. Design and Analysis of Experiments, John Wiley and Sons. New York.

S.305 FURTHER STOCHASTIC PROCESSES

1. Random Phenomena in Time and Space: General review discussion, including mention of point processes. Distributions. Strict Stationarity; second-order stationarity weak[stationarity].

2. Discrete-time Renewal Theory: [i.e. Recurrent Events]. Formulae, periodicity. The Erdos-Feller-Pollard theorem [without proof]. Transience, null-recurrence and recurrence.

3. Markov Chains: Further study of discrete-time chains [an introduction to the classification of states and limit theory; expected transition times]; further development of continuous-time chains [general birth, death and immigration processes, transition intensities; Chapman-Kolmogorov equations and Kolmogorov forward and backward equations; absorption probabilities]; Poisson process with time varying intensity.

4. The Galton Watson Branching Process

5. Renewal Theory: The key renewal theorem; the renewal equation.

6. Semi-Markov Processes: Introductory discussion.

Reading List

(i) Cox, D.R. & Miller, H.D. The Theory of Stochastic Processes Holden Day 1970.

(ii) Feller, W. An Introduction to Probability Theory and its Applications Vol. 1 (2nd ed.) Wiley 1957.

(iii) Karlin, Samuel. A First Course in Stochastic Processes. Academic Press 1966.

(iv) Ross, S.M. Applied Probability Models with Optimization Applications. Holden Day 1970.

S.306 MULTIVARIATE METHODS AND THEORY

Paragraphs 1 and 2 below repeat paragraphs 5 of S.303 (Statistical Methods III) They may of course be ignored if this course begins after that part of S.303 has been covered.

Course Topics

1. Practical examples of multivariate data

2. Preliminary data analysis: examination of data matrix, reduction of the data matrix; definition and calculation of sample summary statistics-means, variances, covariances, correlation; examination and interpretation of sample correlation matrix.

3. One-sample test of vector mean: multivariate analogue of univariate one-sample tests on mean e.g. chi-squared test for case of known covariance matrix, or Hotelling T^2 statistic for case of unknown covariance matrix; implication of rejection of zero mean hypothesis - simultaneous confidence interval for detecting important components; test of structural relationship.

4. Extension to two - sample tests: testing equality of two population means - calculation of pooled covariance matrix.

5. Classification into one of two populations: discriminant function and relevant decision rule.

6. The multivariate normal distribution: marginal and conditional distribution; marginal means and covariances; conditional means and multivariate regression function; conditional covariance.

7. Study of relationships (association): problem of interpretation of many correlations; partial correlation; maximum likelihood estimates of covariances and correlations; joint relationship of one variable with the others - multiple correlation (sample value and tests).

8. Examination of covariance structure: tests for complete independence; use of Wilks criterion based on likelihood ratio.

9. Relationship between two subsets of the variables: test of independence; using one subset to predict another - canonical correlation and canonical variables; test of canonical correlation and reduction in dimensionality.

10. Principal components as another means of reducing and knowing effective dimensionality: calculation and interpretation of principal components.

11. Elements of multivariate analysis of variance: (MANOVA) the one-way grouping and two-way grouping without interaction.

Note: A total of 30 hours of lectures will be devoted to this course. Exercises will be done as home work.

Reading list

(i) Anderson, T.W., An Introduction to Multivariate Statistical Analysis. John Wiley and Sons. New York.

(ii) Chatfield C and Collins, A.J., Introduction to Multivariate Analysis. Chapman and Hall.

(iii) Gordon, A.D., Classification. Chapman & Hall. London.

(iv) Mardia, K.V., Kent, J.L. & Dibby, J.M., Multivariate Analysis. Academic Press. London.

(v) Morrison, D.F., Multivariate Statistical Methods (2nd ed.) McGraw Hill.

(vi) Neil, H. Timm, Multivariate Analysis with Applications in Education and Psychology.

(vii) Press, S.J., Applied Multivariate Analysis, Holt Rinehart and Winston.

S.307 TIME SERIES

1. Time Series: Review of aims - analysis, forecasting, control. Strictly stationary, second-order stationary and non-stationary processes. Stationary processes - theoretical moments, auto-correlations, and partial auto-correlations. Sample moments, auto-correlations, partial auto-correlations.

2. Models: White noise. Autoregressive (AR), Moving Average (MA) and Auto-regressive Moving Average (ARMA) models (emphasis on first and second order models); Stationarity and invertibility; Yule-Walker equations; Forms of ACF and PACF for sample models (Sample versions from simulated series); AR representations. Combined models - possibility of reduction to stationarity by removal of trend and seasonal components (additive or multiplicative model). Brief mention of multivariate and transfer function models.

3. Model Identification and Estimation: Identification of ARMA models by means of sample ACF and PACF. Estimation of parameters. Standard errors of sample moments and of parameter estimates.

4. Forecasting: Minimum mean square error forecasting and alternatives. Use of AR representation. Updating algorithms.

5. Spectral Theory: (Discrete time) [Proofs - some indications, but no attempt at completeness]: Trigonometric polynomials, harmonic decompositions and Fourier series. Spectral representation of the process. Spectral representation of the ACF; Wiener-Khintchine relations. Effect of linear filters. Brief introduction to estimation of spectra.

Note: A total of 30 hours will be devoted to this course, of which 10 hours will be for practical exercises.

Reading list

(i) Anderson, O.D., Time Series Analysis and Forcasting. The Box-Jenkins Approach. Butterworths. London.

(ii) Bloomfield, P. Fourier Analysis of Time Series An Introduction. John Wiley. New York.

(iii) Box, G.E.P and Jenkins, G.M. Time Series Analysis: forecasting and control. 1976. Holden-Day, London.

S.30[8] DEMOGRAPHY II

1. Fertility: Fertility measures based on vital statistics-their computation, uses and limitations. Crude birth rate, general fertility rate, specific fertility rate, adjusted rates. Cohort and period fertility measures. Measures based on censuses and surveys: Child woman ratio; number of children ever born alive (parity) and completed family size. Some methods for obtaining fertility measures from inadequate and deficient data (Brass technique, Coale-Demeny method based on stable populations, reverse survival ratio method). Reproductivity - concepts and measures. Gross and net reproduction rates. Total fertility rate. Reproduction rates by indirect methods. Level of fertility in Africa. Age pattern of fertility and differentials by socio-economic characteristics.

2. Mortality: Various mortality measures-their computation from registration and census and survey data - uses and limitations. Crude and adjusted rates. Measures of infant, foetal and perinatal mortality. Derivation of mortality measures from deficient and incomplete data-Brass, Coale-Demeny, Stolnitz and Arriaga methods. Life tables - their nature and uses. Types of life tables. Life table functions and their relationships. Construction of conventional life tables. Construction of life tables from census data (one census, two or more censuses) and from deficient and incomplete data. Model life tables (UN, Coale-Demeny; Brass etc.). Application of life tables in population studies. Level of mortality in Africa. Age and sex patterns of mortality. Socio-economic and geographic differentials in mortality. Mortality trends in Africa. Morbidity and health situation in Africa.

3. Migration: Measures of migration-problems in migration estimation. Some methods of estimating migration (growth rate, vital statistics and balancing equation, survival ratio). Use of census data (place of birth, place of last or previous residence, duration of residence etc.). Assumptions involved in the various methods. Illustration of applicability to African countries. Levels and patterns of internal migration in Africa. Urbanisation and growth of cities and towns. Impact of migration on development.

4. Dynamics of population change: Effects of fertility, mortality and migration on population size and composition. Closed populations. Concept of stable and stationary populations. Fundamental relationships in stable populations. Estimating vital rates through stable population theory. Quassi stable population concept and its applications. Growth rates. Population models-their need, importance and limitations. Examples of simple models.

5. Population projections: Population estimates. Methods of estimation. Problems in projections. Projections of components - fertility, mortality and migration. Period of projections, number of alternatives (variants). Reliability of projections. Projections of segments of population, viz, school age, labour force, old age etc. Sectoral projections-education, manpower, household. Sub-national projections-regional, urban-rural. Uses and importance of projections.

6. Report writing on analysis of demographic data: Evaluation of data. Preliminary analysis and checking for consistency-convergence of parameters. Inter-relationships and interpretations of findings. Implications for planning and policy formulation. Conclusions.

Note: A total of 30 hours to be devoted to this course. Exercises will be done as home laboratory work.

Reading list

(i) Barclay, G.W. Techniques of Population Analysis. John Wiley and Sons. New York

(ii) Cox, P.R. Demography, Cambridge University Press.

(iii) Henry, L. Population: Analysis & Models, London, Arnold.

(iv) Kpedekpo, G.M.K. Essentials of Demographic Analysis for Africa. Heineman.

(v) Pressat, Roland, Demographic Analysis, Aldine.

(vi) Shryock, H.S., Siegel, J.S. and Associates Materials of Demography. Vols. I and II. Bureau of the Census.

S.309 OPERATIONS RESEARCH II

1. Linear programming: Duality; integer programming - brief introduction to branch-and-bound and cutting algorithms.

2. Game theory: Zero-sum two person games (Extensive and normal forms); saddle points; randomised strategies; linear programming representation.

3. Networks: Maximal flow problems. Minimum network cost problem (transportation problems); out-of-kilter algorithm.

4. Dynamic programming: Multistage decision problems; optimality principle; Markov decision problems (Finite/infinite horizon; discounting; control problems).

Note: A total of 30 hours will be devoted to this course, of which one-third will be for practical exercises/tutorials.

Reading list

(i) Daellenbach, H.G. and George, J.A. Introduction to Operations Research, Allyn & Bacon 1978.

(ii) Smith, D.K. Network Optimisation Practical: a computational guide, Elles Horwood 1982.

(iii) Taha, H.A. Operations Research: an introduction, Collier McMillan 1976.

(iv) Vajda, S. Linear Programming, Science paperbacks, Chapman & Hall 1981.

(v) Wagner, H.M. Principles of Operations Research, Prentice Hall 1972.

S.310 INDUSTRIAL QUALITY CONTROL

1. Acceptance Sampling: Inspection by attributes; the OC curve. Sampling plans and their selection. Inspection by variables.

2. Process Control: Control Charts (action and warning limits; internal and external tolerances; Control charts for qualitative data). CUSUM Charts.

3. Continuous Sampling:

4. Bulk Sampling:

5. Reliability and Life Testing: Failure distributions. Accelerated life testing.

Note: A total of 30 hours is to be devoted to this course, of which one-third should be for practicals.

Reading list

(i) Chatfield, C., Statistics for technology (3rd ed.) Chapman & Hall, London, 1983.

(ii) Institute of Statisticians, Monograph on Cusum Charts.

(iii) Wetherill, G.B., Sampling Inspection and Quality Control (2nd ed.) Chapman & Hall, London, 1977.

S.311 STATISTICAL COMPUTING III

1. Records, files, databases: Types of file (Sequential files; Direct access files). Retrieval and updating procedures according to file organisation. Data base (Introduction to the concept of data bases; Use of data bases).

2. Further considerations on hardware e.g. varieties of machine types and peripherals.

3. Network, communication between micro and mainframe computers

4. Environmental problems (power supply, frequency and voltage, temperature, humidity, dust)

5. Elements of fault finding, electrical safety

6. Security problems and safeguards (machine and data): Back-up copies. Confidentiality (Machine security: Passwords and other software security).

Note: A total of 30 hours is to be devoted to this course. Practical exercises will constitute a third of the time allocated. In addition, practical exercises in other statistical courses will make use of techniques learnt in this course.

Reading list

(i) Date, C.J. An introduction to data base systems. (Systems programming series). Addison-Wesley. 1975.

(ii) Martin James. Security, accuracy and privacy in computer organisation (2nd ed.), Prentice Hall.

(iii) Tanenbaum, Andrew, S. Computer Networks. Prentice Hall International editions.

(iv) Tanenbaum, Andrew S. Structured Computer Organisation (2nd ed.). Prentice Hall.

S.312 ECONOMETRICS

This course treats a number of topics which are of importance in econometric modelling, and it is essential that the eventual applications should not be lost sight of among the technical details.

Course Topics

1. Econometrics: Methods and applications. Aggregated and disaggregated models. Models of the national economy. Models of sectors.

2. Autocorrelation in linear models: Tests; estimation.

3. Stochastic Regression: Consequences; instrumental variables.

4. Lagged Variables: Explanatory variables (Almon scheme, Koyck scheme); dependent variables; estimation.

5. Simultaneous Equation Systems: Structural form and reduced form. Estimation (2SLS, 3SLS, FIML)

Note: A total of 30 hours is to be devoted to this course of which one-third should be for practicals.

Reading list

(i) Johnston, Econometric methods, McGraw-Hill.

(ii) Kane, E.J., Economic Statistics and Econometrics. Harper.

(iii) Kmenta, J., Elements of Econometrics. MacMillan, London .

(iv) Walters, A.A., An Introduction to Econometrics.

(v) Wynn, R.F. & Holden, K., An Introduction to Applied Econometric Analysis.

S.31g BIOMETRY

1. Biological assay: Purpose and types; terminological notation; direct and indirect Assay.

2. Special problems: Agricultural trials; clinical trials.

3. Sampling and estimating biological population

Note: A total of 30 hours is to be devoted to this course of which about a third will be for practical exercises.

Reading list

(i) Colquhoun, D., Lectures in Biostatistics. O.U.P.

(ii) Finney, D.J., Statistical Method in Biological Assay. Hofner.

(iii) Seber, G.A.F., The estimation of animal abundance and related parameters. Griffin, London. 1973.

(iv) Whitehead, J., Sequential Clinical trials. Wiley, 1983.

S.314 SAMPLING TECHNIQUES AND APPLICATIONS

1. Review of general principles of survey design: Objectives of survey, different sampling schemes [one or more stages, one or more phases etc.] Confidence intervals. Sampling and non-sampling errors. Design effect.

2. Stratified sampling: Forming the strata. Number of strata. Determination of strata boundaries. Stratified simple random sampling. Comparison with Analysis of Variance (ANOVA). Unbiased estimation of population means and proportions and their variances. Equal, proportional, optimal and other allocation of sample. Post-stratification. Quota sampling. Domains of Study.

3. Ratio and regression estimators: The ratio estimator. Approximate variance of the ratio estimate. Estimation of the variance of a ratio estimate from a sample. Bias of the ratio estimator. The linear regression estimator with a known b and with b obtained from the sample. Sample estimate of variance. Comparison of ratio and linear regression estimate for large samples (brief mention only). Use of ratio and regression estimators in stratified samples. Bias of regression estimator. Mean square error of ratio and regression estimators. Design effects.

4. Systematic sampling: Description of method. The three main formulae for the variance of the mean of a systematic sample. Advantages and disadvantages of systematic sampling.

5. Multistage designs: Sampling and subsampling of equal clusters. Intra-cluster correlation. Sampling and subsampling of unequal clusters.

6. Multiphase designs: Multiphase sample (description of technique and conditions under which it can be applied - simple ideas only).

7. Selection with probability proportional to some measure of size: Problems and procedures (simple treatment without proofs).

8. Other designs: General aspects of replicated and successive sampling; Issues and problems. Panel designs [general treatment only].

9. Bias and Non-response: Sources of survey errors. Non-coverage. Non-response and how to deal with it. Bias and how to control certain types of bias.

10. African Household Survey Capability Programme: Scope. Types of surveys undertaken [e.g. income, expenditure and consumption survey]. Sampling techniques used; issues and problems. Use of appropriate software (e.g. CLUSTERS) to calculate standard errors.

Note: A total of 30 hours should be devoted to this course of which approximately one-third should be devoted to practical exercises.

Reading list

(i) Cochran, William, G. Sampling Techniques (3rd ed.) John Wiley and Sons. New York, 1977.

(ii) Jessen, Raymond J. Statistical Survey Techniques. John Wiley and Sons. New York.

(iii) Kish, Leslie. Survey Sampling. John Wiley and Sons. New York.

(iv) Murthy, M.N. Sampling Theory and Methods. Statistical Publishing Society, Culcutta, 1967.

S.315 ACTURIAL STATISTICS

Those who wish to offer this course should also take S.308.

Course topics

Basic principles of compound interest
Basic functions and equations of value
Discounted cash flow terminology and methods of investment appraisal
Annuities
Decremental rates and other indices
Analysis of experience data and derivation of exposed to risk formulae
Construction of mortality, sickness, multiple decrement and similar tables from graduated data; selection, graduation methods and their application
Curve fitting
Tests of graduation
Methods for large investigations
Features of principal tables in common use
Vital statistics
Population projections
National social security and pension schemes
Life and other contingencies

Note: A total of 30 hours will be devoted to this course, one-third of which will be for practical exercises.

Reading list

(i) Benjamin B. and Haycocks, H.W. The Analysis of Mortality and Actuarial Statistics. Institute of Actuaries.

(ii) Freeman, H. Finite Differences for Actuarial Students.

(iii) Garside, M.J. Numerical Analysis for Actuarial Students. Institute of Actuaries .

S.350 LABOUR STATISTICS

1. The field of labour statistics: Topics, sources and general scope and content.

2. Uses of labour statistics: Administration of labour laws, manpower utilisation, manpower development, planning and policy-making; levels of living, wage fixing, collective bargaining, socio-economic indicators, wage, income and price policies etc.

3. Labour statistics in relation to other kinds of statistics: Industrial statistics, economic statistics, demographic statistics, agricultural statistics, education statistics, health statistics, etc.

4. International recommendations on labour statistics: ILO and its activities, economically active population, employment, unemployment and underemployment; wages, hours of work, labour cost and employee income; consumer price indices; household income, consumption and expenditure surveys; international comparison of real wages; social security and welfare; occupational injuries and safety standards; collective agreements, trade unionism and industrial disputes; international classifications; index numbers of employment, wage rates and earnings.

5. Methodology of labour force surveys: Objectives, scope and survey design; concepts, definitions, questionnaires and instructions; field procedures, editing, tabulation plans and analysis; illustrative country practices.

6. Methodology of establishment surveys for collection of labour statistics: Directory of establishments - preparation and maintenance; censuses and sample surveys of establishments for collection of data on employment, earnings and supplementary benefits, hours of work, labour cost, etc.; illustrative country practices - methods of data collection, questionnaires and instructions.

7. Use of administrative records for collection of labour statistics: Types of statistics, e.g. industrial disputes, closures and lay-offs, occupational injuries, social security and trade unions; scope and limitations of statistics.

8. Integrated analysis of labour statistics: Manpower analysis and forecasting labour market analysis; analysis of factor productivity; analysis of levels of living.

Note: A total of 30 hours will be devoted to this course, of which about one-third will be for practical exercises/tutorials.

Reading list

(i) International Labour Office, Yearbook of Labour Statistics, ILO, Geneva.

(ii) International Labour Office, Report of the Thirteenth International Conference of Labour Statisticians, I.L.O. Geneva.

(iii) International Labour Office. International Recommendations on Labour Statistics, I.L.O., Geneva.

(iv) International Labour Office, An integrated system of wages statistics. A manual on methods, I.L.O., Geneva.

S.351 EDUCATION STATISTICS

1. International recommendations on education statistics: Purpose, definitions, concepts, classifications, procedures and problems of collecting and analysing education statistics in Africa. The International Standard Classification of Education (ISCED).

2. Data Requirements: Scope, types of questions, preliminary tabulation plan.

3. The Annual School Census: The statistical infrastructure.

4. Design of Questionnaires: Questionnaire lay-out, content, data processing considerations (to cover only aspects not dealt with in other core subjects).

5. Rates and ratios: Intake rates, transition rates - promotion, repetition and drop-out rates, teacher retention rates; over-all (or crude or general) age-specific, standardized enrolment ratios, level-specific, net and gross enrolment ratios; pupil-teacher ratios.

6. Education flow models: Types; their use in reconstructing the school history of a cohort and for projecting enrolment in primary education. Projection of teacher requirements.

7. Science and technology statistics: International recommendations on science and technology statistics; data requirements; scientific and technological indicators, sources of data.

Note: A total of 30 hours should be devoted to this subject, of which 50 per cent should be spent on exercises based on relevant country data.

Reading list

(i) UNESCO. The International Standard Classification of Education. UNESCO, Paris 1977.

(ii) UNESCO. Yearbook of Education Statistics, UNESCO, Paris.

(iii) UNESCO. Revised recommendation concerning the International Standardization of Education Statistics, adopted by the General Conference of UNESCO at its twentieth Session in Paris, November 1978.

(iv) UNESCO. Statistics of Education in developing countries (an introduction to their collection and analysis). UNESCO, Paris, 1983.

(v) Analysing and projecting school enrolment in developing countries: A Manual of Methodology, Statistical reports and studies No. 24, UNESCO, Paris.

(vi) UNESCO. Guide to statistics on Science and Technology. UNESCO, 1984.

(vii) UNESCO. Manual for Statistics on Scientific and Technological Activities, UNESCO, 1984.

S.352 HEALTH STATISTICS

1. Health indicators: Uses and criteria for selection: health policy indicators, social and economic indicators, indicators of the provision of health care (coverage, physical accessibility, population served - percentage, socio-economic accessibility, population/health personnel ratio), health status indicators (low birth weight - percentage, low weight for age; low height for age;low weight for height - percentage, small upper arm circumference - percentage infant mortality rate, child mortality rate, under-5 mortality rate, under-5 proportionate mortality, life expectancy, maternal mortality rate, crude birth rate, disease specific death rate, proportionate mortality from specific diseases, morbidity-incidence rate, morbidity-prevalence rate, long-term disability-prevalence).

2. Sources of health indicator data: Vital events registers, population and housing censuses, routine health service records, epidemiological surveillance, sample surveys, disease registers.

3. General principles of a health statistics system: Fields of health statistics, recording and reporting, methods of data collection, concepts and definitions, design of questionnaires and record books.

4. Classification of diseases and causes of death: The need for classification, principles of a statistical classification of diseases, International Classification of Diseases - general principles, history, special tabulation lists.

5. Nutrition surveys: Classifications, methods of data collection and analysis.

Note: This syllabus is based on the Plan of Action for Implementing the Global Strategy for Health for All by the Year 2000. A total of 30 hours is to be devoted to this course, of which one-third should be for practicals.

Reading list

(i) World Health Organisation. Development of indicators for monitoring progress towards health for all by the year 2000. HFA series No. 6. WHO, Geneva, 1981.

(ii) World Health Organisation. Global strategy for health for all by the year 2000. WHO, Geneva.

(iii) Lwanga and Tye. Twenty lessons and seminar outlines in health statistics. WHO, Geneva.

S.353 AGRICULTURAL STATISTICS

1. Source of data: Administrative records and data registers, censuses of population, censuses of agriculture, multi-round sample surveys.

2. Data applications-methods of collecting data: Frames and statistical units, sample design, techniques of collection and time coverage.

3. Concepts, definitions and classifications: Topics investigated in agricultural censuses and surveys: size and type of holding, sectors of agriculture, agricultural population, employment in agriculture; wages.

4. Land utilization statistics: Uses, statistics of irrigation, aerial photography measuring instruments.

5. Agricultural trade statistics: Commodity classification, customs area and partner countries.

6. Agricultural price statistics: Methods of collecting agricultural price data - wholesale and retail prices - index number of prices.

7. Statistics on agricultural inputs: Methods of collecting fertilizer, pesticides, agricultural machinery and equipment statistics.

8. Fishery statistics: Methods of collecting fishery data, fishery surveys, estimation of forestry production:

9. Forestry statistics: Methods of collecting forestry data, forestry censuses and surveys, estimation of forestry production.

10. Food consumption statistics: Food consumption surveys: economic grain equivalent, nutritive values, nutritional requirements, measuring techniques.

11. Nutrition surveys: Methods of data collection and analysis.

12. Food balance sheet: Procedure for preparation; standardization problems.

Note: A total of 30 hours is to be devoted to this subject.

Reading list

Casley, D.J. and Lury, D.A., Data Collection in developing countries Oxford University Press.

S.354 PRICE AND QUANTITY STATISTICS

1. Uses of price and quantity statistics

2. Choice of items: Representativity, reliability, relevance, comparability

3. Definition of items and their specifications: Unit of measurement, selection of items and their specifications.

4. Choice of outlets and their definition

5. Choice of base period - based on the household survey

6. Scope, coverage and types of price indexes

7. Methods of price collection: Selection of localities and outlets, frequency of collecting prices for different categories of goods and services, treatment of discounts, sales prices, black market prices, hire-purchase on credit terms, second hand purchases, import prices, indirect taxes; observations in intra-company transactions, volume of sales, multiple delivery orders, conditions of sales, commodity taxes etc.; special techniques for price collection in respect of electricity, gas and water; housing.

8. Index numbers: Applications or uses of index numbers including their use and inter-relationship with International Comparison Project (ICP); weights and composition; price relatives, simple averages, unit values, weighted aggregates (Lasperyre's, Paache's and Fisher's ideal indexes); classification of index (item groupings such as SITC for traded goods, ISIC for economic activity grouping; this will depend on the type of index being compiled), frequency of the index; change of base.

9. Practical problems relating to prices: Price controlled items, i.e. official prices versus prices paid, seasonal items, quality changes, collection in non-specified outlets, unit of measurement etc.

Note: A total of 30 hours is to be devoted to this course, of which a third should be for practical exercises.

Reading list

United Nations. Guidelines on Principles of a System of Price and Quantity Statistics. Statistical Papers. Series M. No. 59. United Nations, New York, 1977.

5.355 SOCIAL STATISTICS

1. Nature, purpose and sources of social statistics: Sources, objectives in collecting, compiling and analysing social statistics; conceptual problems; validity and reliability concepts, definitions and classifications; measurement problems in social surveys.

2. Social indicators: The need for social indicators; criteria for defining and selecting social indicators; methods of constructing social indicators. Summarization; quality of life index.

3. Sectoral concerns and their relevant statistics: Population (components, growth, size, characteristics and distribution); social class, stratification and mobility; employment, wage and price trends and social security, the unemployed, the inactive; the distribution of income, consumption; accumulation and net worth; levels of living, poverty and inequality; health; education; housing; women, youth and children; social welfare, popular participation, crime prevention and criminal justice; environment; disability, the allocation of time and use of leisure.

4. Data requirements for social planning: Types, level of disaggregation, special groups such as the disabled and the aged.

5. Studies in the integration of social statistics: System of social and demographic statistics (SSDS) and the framework for the integration of social and demographic statistics.

Note: A total of 30 hours is to be devoted to this course of which 10 hours should be for practical exercises and tutorials.

Reading list

(i) United Nations: Social indicators: Preliminary Guidelines and illustrative Series. Statistical Series M. No. 63. United Nations, New York, 1978.

(ii) United Nations: Towards a System of Social and Demographic Statistics. United Nations, New York, 1975.

(iii) United Nations: Studies in the Integration of Social Statistics: Technical Report, Series F. No. 24. United Nations, New York, 1979.

S.356 INTERNATIONAL TRADE STATISTICS AND BALANCE OF PAYMENTS

1. Sources and uses of trade statistics

2. Comparability of international trade statistics

3. Conceptual framework of international trade statistics: Coverage of the statistics; trade system; commodity classification - Standard International Trade Classification; valuation; c.i.f., f.o.b., etc; quantity measurement; partner country.

4. Collection and compilation of data: Source documents; recording period; receipt of documents by compiling agency; posting to ledgers for manual operation; coding for computer processing; keying or punching data for computer edit; receipt of computer data by compiling agency; validation of data and error correction; computer file of basic trade data.

5. Publication and presentation of trade data: Provisional and final figures; periodicity of data for tables; preparation of tables from ledgers; accessing computer file for table preparation; publication of trade statistics; availability of detailed information for enquiries; maintaining data in time series.

6. Provision of data for other statistical systems or economic studies: National accounts; balance of payments; input-output analysis; foreign trade indices; shipping and cargo statistics.

7. Computerization of external trade system: Requirements of system; edit requirements; table requirements; system design; system testing and acceptance; implementation of system.

8. Balance of payments: Definition of balance of payments, definition of and types of changes in assets; concept of economic transactions; the double entry system for recording; definition of resident; valuation, unit of account and time of recording; concept of tangibles, direct investment, investment income, government and other transfers, reserves and related items; balance of payments presentation - relationship to the UN System of National Accounts.

Note: A total of 30 hours will be devoted to this course of which 10 hours will be for practical exercises.

Reading list

(i) Paul A. Samuelson. Economics: An Introductory Analysis, Section 31, McGraw-Hill Company Inc. New York, 1961.

(ii) International Monetary Fund, Balance of Payments Manual.

(iii) United Nations. Standard International Trade Classification, Rev. 3, United Nations, New York.

S.357 NATIONAL ACCOUNTS

1. General: Origin and development of national accounting, its usefulness.

2. Concepts and Definitions: Concept of production, production boundary, final and intermediate product, definition of value added, gross and net measures, depreciation, capital consumption; classification of transactions and transactors, definition of commodities, industries and activities; producers of government services, government enterprises, the public sector; valuations at market price and at factor cost; GDP at factor cost, GDP at market prices; national and domestic product; consumption expenditure; capital formation; the consolidated accounts of the nation; the UN System of National Accounts.

3. Public Authority Accounts: Analysis of accounts of public authorities; central government; local authorities; public corporations.

4. Real Product Accounting: Need for volume measures of national output in constant prices; problems of real product accounting, pricing, weighting, output definitions, conceptual considerations in preparation of real output measures; real output by type of final expenditures and by industry of origin; implicit price deflators.

5. Input-Output Accounts: Origin and development of input-output studies, basic ideas of input-output tables, input coefficients.

6. Sources of Data and Methods of Estimation: Detailed consideration of sources of data and methods of estimation at current prices of value added in agriculture, mining and manufacturing, construction; trade and transport, ownership of dwellings; financial intermediaries, and services.

7. Sources of data and methods of estimation of: Capital formation; consumption expenditure; input-output tables.

8. Sources of data and methods of estimation at constant prices of gross domestic product: By industry of origin; by types of expenditure.

9. Uses of National Accounts: Uses of national accounts statistics for economic planning and policy formulation; limitations of national accounts statistics.

Note: A total of 30 hours is to be devoted to this course, 10 hours of which will be for practical exercises.

Reading list

United Nations. A System of National Accounts. Studies in Methods. Series F No. 2 Rev. 3. United Nations, New York, 1968.

S.358 SOCIAL ACCOUNTS

1. The circular flow of economic activity: Institutions (households, producers, the rest of the world). Markets (factor and products markets). Uses of products (intermediate demand in the production process by producers, final consumption by households, exports).

2. Concepts, definitions and classifications: Households (workers, capitalists), labour and labour markets, capital market. Income; producers.

3. Income and expenditure accounts of groups or classes of households

4. Income distribution of households: Sources and methods of estimating the data on the distribution of income, consumption and accumulation of the household sector. Distribution of households by socio-economic characteristics.

5. Social Accounting Matrix (SAM) as a data system: Description of system. Characteristics of system: principal uses of SAM. Data Requirements. Application of fixed coefficient models to a SAM framework. SAM and Input-Output (I-O) representation - advantages of SAM over the I-O tables of the System of National Accounts. The I-O as a truncated SAM. Comparison with Computable General Equilibrium (CGE) models.

Note: A total of 30 hours should be devoted to this course, of which 10 hours should be for practical exercises. A pre-requisite for this course is S.357.

Reading list

(i)

(ii)

(iii)

S.359 FOOD ACCOUNTS

1. General: Increasingly serious food problems in African countries; need for relevant tool for analysis; origin and development of the FAM, its usefulness and limitations.

2. Concepts and Definitions: Concept of production, food commodity flows, food systems, and institutions; classification of food producers and consumers and institutions dealing with marketing, distribution and storage of food.

3. Methods of estimation, analysis and presentation: The selection of commodities and identification of institutions involved in food commodity flows; the construction of the Matrix; the modelling of technical and behavioural relations; the simulation of the impact of food policy issues such as pricing policy and marketing strategies on the response of producers and consumers, national food demand and requirement etc.; methods of presentation of results in useful manner to food policy makers and planners.

4. Sources of Statistical Information: Domestic food production (the need for disaggregation); food imports and food aid; food distribution - marketing, relief food; food consumption (the need for disaggregation); food stocks. Producers, consumers, institutions. The use of data for micro-studies, institutional reporting, rapid assessments for the construction of the FAM.

5. Uses of FAM: Uses of FAM for the management of national food supply including the distribution of relief food; uses of FAM for policy formulation in agricultural development, pricing, marketing strategy, and national food security; uses of FAM for the identification of data requirements for strengthening national data collection systems.

Note: A total of 30 hours will be devoted to this subject, of which 10 hours should be for practical exercises.

Reading list

(i)

(ii)

(iii)

(iv)

S.360 FINANCIAL STATISTICS

1. Data sources, coverage and applications: Nature of government and government accounts. Definition of the public sector (Central government; state, provincial or regional government; local government; social security funds; supranational authorities; departmental enterprises; non-financial public entrprises; financial institutions; non-financial public sector). Policy and practical uses of data.

2. Analytical framework of government financial statistics: Basic distinctions - revenue (current, captial), expenditure (current, captial), grants (current, capital), public debt, net lending, financial, deficit, surplus, saving, debts (outstanding, floating); gross fixed capital formation; gross capital formation. Relationship with Monetary Accounts, National Accounts and Balance of Payments.

3. Principles of economic and functional classification of government transactions: Detailed definitions of types of government agency; principles and details of economic classification; application of the economic classification scheme. Principles and details of functional classification. Economic-functional classification. Reconciliation with United Nations System of National Accounts.

4. Statistics of financial institutions

Note: A total of 30 hours will be required for this course, of which 10 hours should be spent on practical exercises.

Reading list

(i) International Monetary Fund: A manual of government finance statistics.

(ii) Prest, A.R.: Public Finance in developing countries. Weidenfeld and Nicholson.

(iii) United Nations: A manual for economic and functional classification of Government transactions.

(iv) United Nations. A System of National Accounts. Studies in Methods Series F No. 2 Rev. 3. United Nations, New York. 1968.

(v) Williams Alan: Public Finance and Budgetary Policy. George Allen and Unwin.

S.361 INDUSTRIAL STATISTICS

1. Introduction: The aims of the industrial statistical system; an historical overview of the development of industrial statistics in Africa; sources of statistical data of industry; scope, coverage and frequency of industrial surveys; methods of enumeration.

2. Statistical Units and Classification Systems: The basic units of statistical inquiries (enterprises, establishments and local unit); kind-of-activity units and units of homogeneous production; ancillary units, the main classification systems in current use in economic statistics (classifications of activities and commodities); the criteria used in constructing and implementing classification systems for economic activities and commodities; a few examples of classification systems.

3. The Basic Concepts in Industrial Statistics: Characteristics of establishments; employment and earnings; production; consumption and related items; value added and contribution of the industrial sector to the gross domestic product; changes in stocks; gross fixed capital formation.

4. Organization and Conduct of Industrial Surveys: General planning and organization of an industrial survey (preparation and approval of the survey programme, legislative requirements and organizational structure, organizing advisory committees and publicity programme, decisions on scope, coverage, classification and methods of enumeration, treatment of confidential information); building up and maintaining a directory of industrial establishments; registration of enterprises and establishments; questionnaires and other data-collection forms; training of enumerators; organization and conduct of surveys on household and small-scale industries including those in the informal sector (methods and identification problems relating to household industries, data requirements, types of surveys and methods of enumeration in current use, sampling techniques); data processing (manual and computerized checks, tabulation and review of tabulated data), preliminary and final publications of results.

5. Analysis and Uses of Statistical Data on Industry: Industrial statistics in the framework of National Accounts and input-output analysis; compilation, updating and correction of index numbers of industrial production; measurement and comparison of productivity; relationship between industrial statistics and other statistics.

Note: A total of 30 hours is to be devoted to this course, of which 10 hours should be set aside for practical exercises/tutorials.

Reading list

(i) United Nations Recommendations for the 1983 World Programme of Industrial Statistics. Part one. Statistical Papers Series M. No. 71 (Part 1). United Nations, New York.

(ii) United Nations Recommendations for the 1983 World Programme of Industrial Statistics Part Two. Statistical Papers Series M. No. 71 (Part II). United Nations, New York, 1981.

S.302 TRANSPORT AND COMMUNICATIONS STATISTICS

1. The sources and nature of transport and communications statistics: Surveys (periodic and ad-hoc road counts, corporation and traffic surveys) and administrative records: classification of mode of transport (sea, rail, road, air, water multimodal, etc.); types of moving equipment; infrastructure. Classification of mode of communications (telephone, radio, television, cinema, etc.).

2. Road Statistics: Data requirements. Data applications. Road networks and different classes of roads. Road safety statistics.

3. Rail statistics: Length of rail, number of passengers, passenger-km, number of ton-km, rolling stock; productivity indices, stock and lack coefficients.

4. Port and shipping statistics: Uses of data. The port system. Manifests. Commercial fleet. Customs declarations and sea traffic statistics. Cover rate. Freight and passenger balance. Indicators of sea environment. Domestic navigation statistics. The unified system of maritime statistics.

5. Air transport: Types of statistics (passenger and freight traffic, capacity offered, returns and operating costs). The International Civil Aviation Organization Statistical Programme: Major requirements and statistical classifications.

6. Communications statistics: Data applications and requirements. Equipment and audience/readership statistics.

7. The compilation and uses of price and quantity indices in the field of transport:

8. Forecasting techniques for transport and communication needs

Note: A total of 30 hours is to be devoted to this course, of which 10 hours should be for practical exercises.

Reading list

(i) Manual of ICAO statistical programme, Doc. 9060-AT/7.3.

(ii) Manual on a uniform system of port statistics and performance indicators. United Nations, Geneva.

S.303 DISTRIBUTION STATISTICS

1. Use, source, scope and coverage of distributive trade: Needs and uses of distributive trade statistics (government, business and other). Data applications. Sources - censuses of distribution or establishments covering most of the distributive trade sector; surveys of establishments covering limited parts of the distributive sector; surveys other than establishment censuses or surveys that yield data on distribution; administrative records, specially designed surveys. Wholesale and retail trade and related service establishments. Decennial, quinquennial, annual, quarterly and monthly inquiries and types of data to be collected in each type of inquiry - establishment characteristics, employment, wages and salaries, expenditures and sales for fixed assets during inquiry year; inventories at beginning and end of inquiry year of goods intended for sale, whether processed or not; value of all sales; accounts receivable as of end of inquiry year; value of all purchases during inquiry year of goods intended for sale, whether processed or not. Reporting unit - the establishment.

2. Concepts, definitions and classifications: Kind of activity, type of business, type of operation, kind of economic organization, kind of legal organization, scope and valuation of expenditures, distinction between new and second-hand fixed assets; classification by sales of goods and of services by kind of activity.

3. Organization and Conduct of Distributive - trade surveys: General planning and organization (legislative requirements, organization structure, staff requirements, organizing advisory groups, methods of data collection and processing), scope and coverage of survey. Management. Coverage and classification. Questionnaires and other data collection forms. Editing and tabulation. Publication and dissemination.

4. Sampling techniques applicable to surveys of distributive trades and services: Frames (area and list-sample frames), size and nature of primary sampling units; methods of allocating total sample among the various kinds of businesses; selection procedures. Treatment of new and defunct establishments; use of rotating panels.

Note: A total of 30 hours should be devoted to this course, of which one-third should be for practical exercises on questionnaire design, frame construction and sample design and selection.

Reading list

(i) United Nations. International recommendations on Statistics of the Distributive Trades and Services. Statistical papers, Series M No. 57. United Nations.

(ii) United Nations. Organization and Conduct of Distributive - Trade Statistics. Studies in Methods Series F No. 19. 1977 United Nations.

S.364 ENVIRONMENT STATISTICS

1. Environment Assessment in Africa: Environment problems and concerns - human settlements, land, natural resources, energy and pollution.

2. Scope and sources of environment statistics: Natural environment (air, land/soil, water), human settlements, natural disasters, pollution and natural resources. Sources - censuses, surveys, administrative records and monitoring networks (ground stations, air).

3. Data requirements and uses: Water quality and supply, land use and degradation, drought and desertification, deforestation, natural disasters, ecosystems, pollution and waste discharge, conservation of natural resources, human settlements and environmental impacts of plans, programmes and projects. Environmental/ecological indicators. Compilation of a national Directory of Environment Statistics.

4. Characteristics and uses of the United Nations Framework for the Development of Environment Statistics (FDES): Structure, contents, relationships to national and resource accounting systems - UN System of National Accounts, Material-Energy Balance Statistical System (MEBSS) and the Stress-Response Environmental Statistical System (STRESS). Framework tables. Purposes and properties of the FDES and its applications (review of environmental problems, concerns and related statistical topics: determination of statistical variables: assessment of data requirements, sources and availability: structuring of information systems and statistical publications).

5. Resource Needs: Development of institutional and manpower capabilities. Determination of national priority areas.

Note: A total of 30 hours will be devoted to this course, of which 10 hours will be for practical exercises relating to the country of interest.

Reading list

United Nations. A Framework for the Development of Environment Statistics. United Nations, New York. 1984.

5.365 ENERGY STATISTICS

1. Uses of energy statistics: Differences between energy statistics and other economic statistics in respect of applications; needs of particular energy industries; outlook for energy supplies; statistical input to industrial management decisions (energy content of manufactured industries, energy analysis; energy models), scope for energy saving. Direct and indirect effects of price changes for energy sources; environmental protection.

2. Sources of energy: Renewable and non-renewable sources. Modern and traditional sources.

3. Concepts, definitions and classifications: Energy; final energy uses (useful energy, and use by purpose), primary and secondary energy reserves, production, demand, commercial and non-commercial fuels, energy balance, value and physical data on energy input, consumption and import dependence; visible and invisible trade in energy, boundary problems (system boundary, flows and stocks).

4. Accounting levels and units: Primary energy input to final demand, primary energy input to hydro-electricity, primary energy input to renewable sources of energy, animal and human energy, primary fuel inputs to trade, gross and net calorific values. Accounting units (tons of coal equivalent, tons of oil equivalent, other accounting units such as British thermal unit, joule, therm, teracalorie, terajoule, kcal).

5. Energy balances: Alternative balance formats, the backward look - "top down" balance; other balancing problems (double counting, pumped storage generation; oils returned to refineries, original units and common units, conversion factors, matrices and time series).

6. Energy consumption surveys: Survey design and development of questionnaire. Accounting methodologies. Interpretation of results, demand and end-user assessment, supply prospects for biomass energy resources, assessment of supply and demand balances.

7. Other energy statistics: Energy balances and input/output, derived statistics, flow charts, energy and the environment regional balances.

Note: A total of 30 hours is to be devoted to the subject, with about one-third of the time being devoted to practical work.

Reading list

United Nations: Concepts and Methods in Energy Statistics, with special reference to energy accounts and balances. A Technical Report, Studies in methods series F No. 29, United Nations, New York, 1982.

S.366 STATISTICAL ORGANIZATION

1. Functions of a Statistical Office: Role of statistical agencies in the development process. Uses of statistical data. Producer/user committees.

2. Internal Organizational Structures of a Statistical Agency: Delegation of authority, organization by subject-matter or by function. Integration. Degree of centralization of a statistical office [advantages and disadvantages]. Organizational chart, statistical legislation, staffing and staffing policy. Organization of regional offices.

3. Capabilities of a statistical agency:
External [producer-user committees, dissemination, status and location] internal [range and level of personnel required, logistical support. EDP capability, data base, the place of methodological research and analysis in statistical operations]. Continuous survey capability. Cartographic capability.

4. Programming and budgeting of statistical activities: Priority setting and costing. Preparation of work programmes and budgets. Implementation and monitoring of work programme. Evaluation of work programme outputs.

5. Dissemination of Data: Dissemination policy. Determination of list of publications. Periodicity. Pricing policy. Readership surveys. Relationship with UN Statistical Office, statistics decisions of UN specialised agencies and other international statistical agencies.

Note: A total of 30 hours will be devoted to this course, of which one-third will be for practical exercises/tutorials.

Reading list

(i) Munich Centre for Advanced Training: Report of the Seminar on the Organization of a Statistical Service (6-30 August, 1977). Munich Centre for Advanced Training, Munich 1977.

(ii) Munich Centre for Advanced Training: Report of the Seminar on Setting and Implementing of Statistical Priorities (6-25 August 1979). Munich Centre for Advanced Training. Munich 1979.

(iii) Munich Centre for Advanced Training: Papers prepared for the Seminar on Setting and Implementing of Statistical Priorities (6-25 August). Munich 1979.

United Nations. The Organization of National Statistical Services: A Review of Major Issues. Studies in Methods Series F No. 21 United Nations 1977.

S.367 PRACTICAL WORK

See Introduction, section (D).